COST AND PERFORMANCE REPORT

Pump and Treat of Contaminated Groundwater at the
Mid-South Wood Products Superfund Site
Mena, Arkansas

September 1998

Prepared by:

U.S. Environmental Protection Agency
Office of Solid Waste and Emergency Response
Technology Innovation Office

SITE INFORMATION

Identifying Information:

Mid-South Wood Products Superfund Site
Mena, Arkansas

CERCLIS #: ARD092916188

ROD Date: November 14, 1986

Treatment Application:

Type of Action: Remedial

Period of operation: September 1989 - Ongoing
(Performance data collected through December 1996; pumping data collected through December 1997)

Quantity of groundwater treated during application: 100.6 million gallons through December 1997

Background

Historical Activity that Generated Contamination at the Site: Wood treatment facility

Corresponding SIC Code: 2491 (Wood Preserving)

Waste Management Practice That Contributed to Contamination: Improper disposal, on-site spills

Location: Mena, Arkansas

Facility Operations: [2 3]

- The Mid-South Wood Products site is located on 57 acres in western Arkansas. Several streams flow through the site, feeding either the Ouachita or the Little Rivers. Previously, there were 14 private drinking wells nearby, serving the 18 properties adjacent to the site. Currently public water serves the site.
- The site was originally developed in the late 1930s to produce untreated wood posts. In 1955, the facility added pressure treating to its process. From 1967 to 1977, the site was operated as a pentachlorophenol (PCP) and creosote wood treatment facility. In 1977, the PCP plant was abandoned and a new plant was built to treat the lumber with a chromated copper arsenate (CCA) wood-treating process.
- The site includes the old wood treatment plant, an unlined waste pond, and two land farms. The waste pond was a collection basin for the waste from the PCP and creosote treatment processes.
- From 1978 to 1981, the Arkansas Department of Pollution Control & Environment (ADPC&E) sampled drinking wells near the site, investigating the source of a fish kill that occurred in November 1976. The source was ultimately determined to be an unauthorized release of wastewater from the waste pond.
- In 1978, an unsuccessful attempt was made to close the waste pond. Further contamination of the site resulted when liquids and sludge from the pond were sprayed on and around the land farm areas. A portion of the contaminated land farm soils were placed back into the waste pond as fill [2].
- An Administrative Order (AO) was issued by ADPC&E in March 1983 that directed the PRPs to perform short-term remedial actions and conduct a full site investigation.
- The site was placed on the NPL in 1983.
- EPA conducted a Remedial Investigation/ Feasibility Study (RI/FS) and a supplemental remedial investigation (SRI) of the CCA plant area in 1984 and 1986, respectively. The results of the investigations showed that the area around the CCA treatment plant was contaminated by spills of the wood treatment products

SITE INFORMATION (CONT.)

Background (Cont.)

and the unlined waste pond was contaminated by the disposal of wood treatment wastes.

- Groundwater samples collected during the RI/FS and the SRI from wells located around the waste pond, land farms, and CCA plant showed high concentrations of PCP. Lower concentrations of arsenic and chromium also were found in the groundwater.

- As specified in the Record of Decision (ROD), the contaminated soils from the waste pond and the old plant area were excavated for source control, stabilized, and consolidated in the waste pond. All other contaminated soil from the site was consolidated in one of the land farms. The waste pond and land farm were then capped with clay, sand, and topsoil to prevent further contamination of the groundwater.

Regulatory Context:

- EPA signed the final ROD for this site in September 1986. The ROD addressed both soil and groundwater actions.

- A Consent Decree was signed by the two identified Potentially Responsible Parties (PRPs) and entered in the Arkansas District Court on May 16, 1987.

- Site activities are conducted under provisions of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) of 1980, as amended by the Superfund Amendments and Reauthorization Act (SARA) of 1986 §121, and the National Contingency Plan (NCP), 40 CFR 300.

- National Pollutant Discharge Elimination System (NPDES) permits were required to discharge treated groundwater to surface drains.

Groundwater Remedy Selection:
Groundwater extraction and treatment via carbon adsorption was selected as the remedy for this site.

Site Logistics/Contacts

Site Lead: PRP

Oversight: EPA

Remedial Project Manager:
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U.S. EPA Region VI (6SF-AP)
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*Indicates primary contacts

MATRIX DESCRIPTION

Matrix Identification

Type of Matrix Processed Through the Treatment System: Groundwater

Contaminant Characterization [1, 2, 6]

Primary Contaminant Groups: Semivolatile organic compounds and inorganics

- The contaminants of concern at the site are PCP, chromium, arsenic, and polynuclear aromatic hydrocarbons (PAHs), including benzo(b+k)fluoranthene, chrysene, and benzo(a)anthracene [1].
- The maximum concentrations detected in shallow groundwater during the RI include PCP (10,230 µg/L), chromium (183 µg/L), arsenic (18 µg/L), fluoranthene (263 µg/L), chrysene (37 µg/L), and benzo(a)anthracene (35 µg/L) [1].
- No samples were taken of the groundwater in the underlying bedrock unit during the RI, as additional study of the deep contamination was considered to be too costly, given the complexity of the hydrogeology. However, a sampling event in 1990 (after remedial operations began) revealed significant contamination in a well drilled to 172 feet below ground surface.
- The presence of light nonaqueous phase liquid (LNAPL) contamination by carrier oils has been observed directly [2]. In addition, fluoranthene and PCP were detected at concentrations at or greater than 60% of their aqueous solubility, suggesting the presence of dense nonaqueous phase liquids (DNAPLs). As noted above, while confined to the upper portion of the bedrock, DNAPLs were subsequently found at depths of 172 feet during deep drilling [2]. Figure 1 illustrates site layout and the location of monitoring wells. The monitoring wells are located primarily around the land farm and the old pond.
- Contaminants have been found only along fractures in rock along the fault line; therefore no continuous contaminant plume was defined. Thus, no plume map or volume estimate was generated.

MATRIX DESCRIPTION (CONT.)

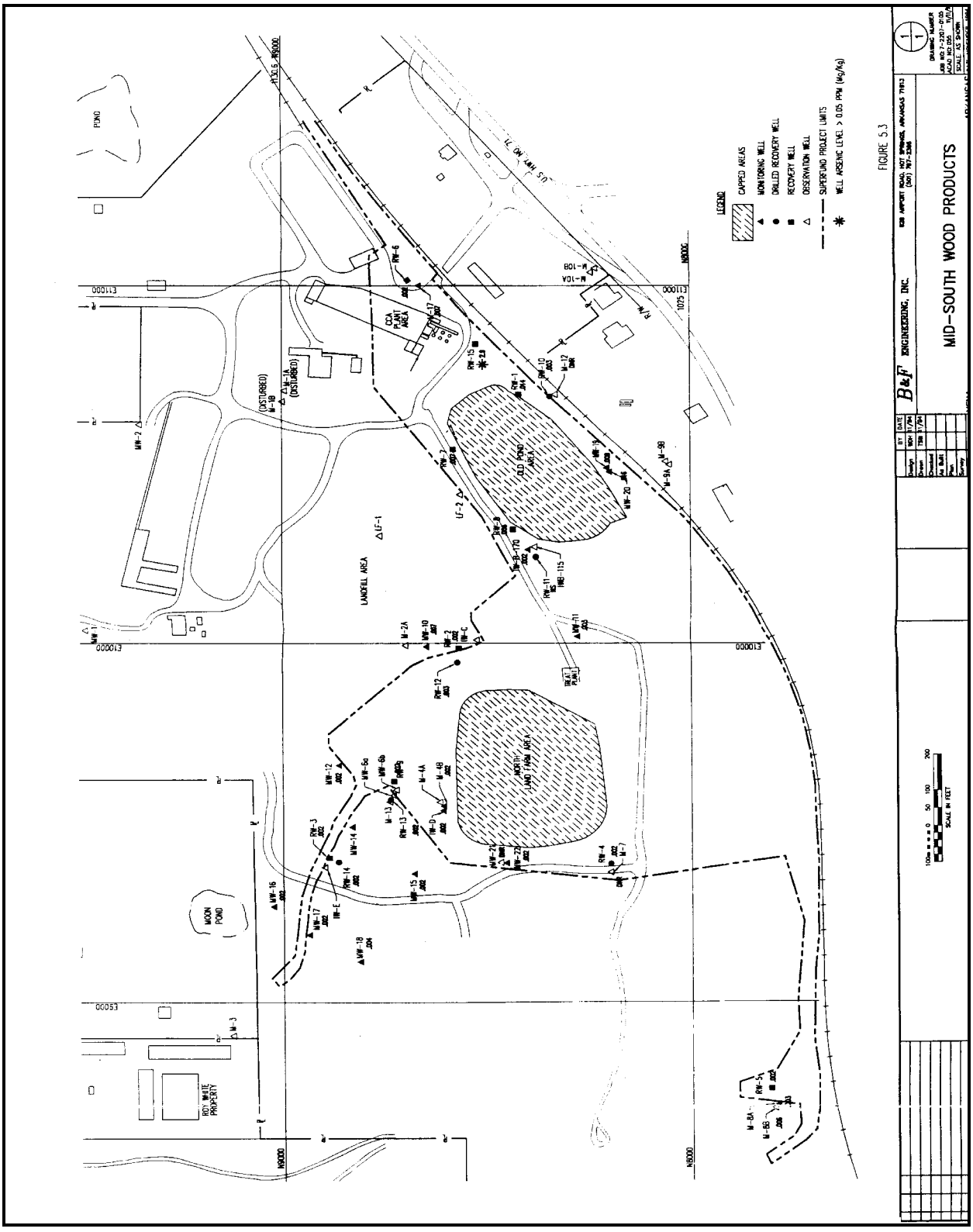

Figure 1. Site Map (November 1995, Best Copy Available) [6]

MATRIX DESCRIPTION (CONT.)

Matrix Characteristics Affecting Treatment Costs or Performance

Hydrogeology [1,2]:

One distinct hydrogeologic unit has been identified beneath this site. This unit has two separate geologic features: a thin layer of sandy, gravelly material overlying the sandstone bedrock of the Mississipian Age formation. A fault zone in the bedrock runs west to east and passes under the old waste pond. The fault zone is characterized by highly fractured shales and influences groundwater flow patterns by creating a highly permeable zone within the bedrock. Groundwater flows primarily to the west-northwest, except in the eastern two-thirds of the site, where it flows westerly to southwesterly. Groundwater flow velocity along the fault is approximately 20 ft/yr, or 0.055 ft/day. Higher velocities of 30 to 60 ft/yr have been observed along the slopes of the site.

Unit 1	Overburden Aquifer	Consists of 1 to 10 feet of silt, sand, and clay with gravel. The gravel consists primarily of angular rock fragments. The saturated zone in soil exists 1 to 9 feet above the lower bedrock formation.
Unit 2	Bedrock Aquifer	Consists of consolidated sandstone and shale bedrock. Groundwater mainly occurs in the joints, fractures, and bedding planes. Depth of water within the bedrock unit is generally 30 feet, with infiltration into deeper zones to depths of 172 feet.

Tables 1 and 2 present technical aquifer information and well data, respectively.

Table 1: Technical Aquifer Information

Unit Name	Thickness (ft)	Conductivity (ft/day)	Average Velocity (ft/day)	Flow Direction
Overburden Aquifer	1 - 10	**NA**	0.055	West-Northwest
Bedrock Aquifer	>10	**NA**	0.082	West-Northwest

Source: [2]

TREATMENT SYSTEM DESCRIPTION

Primary Treatment Technology

Pump and treat with liquid-phase carbon treatment

Supplemental Treatment Technology

Oil/water separator

TREATMENT SYSTEM DESCRIPTION (CONT.)

System Description and Operation

Table 2: Extraction Well Data

Well Name	Unit Name	Depth (ft)	Yield (gal/day)
RW-1, RW-2, RW-3, RW-5, RW-6, RW-7, RW-8, RW-9, RW-15	Overburden Aquifer*	12.8 - 23.4	8.7 - 3,216
RW-4, RW-10, RW-11, RW-12, RW-13, RW-14	Bedrock Aquifer	21 - 170	4,167 - 8,487

*Overburden wells are screened within a French drain.

Source: [2]

System Description

- In response to the 1983 AO, an interim extraction system was built in late 1984 and operated from early 1985 until 1989. The system consisted of three pairs of extraction wells and French drains. Each well was screened in a drain. The system was designed to collect contaminated groundwater from shallow depths where flow and contamination were expected to be the greatest [2]. Table 2 presents extraction well data.

- The 1986 ROD specified an expansion of the existing system as the final groundwater remedy. This expanded extraction system, which began operating in the summer of 1989, consisted of nine extraction wells (including the original three sets of drains), screened in eight French drains, and six deep extraction wells drilled into the bedrock formation to depths up to 170 feet [2].

- The original three French drains, installed in 1984, are located on a NW/SE axis across the site along the fault zone. Three of the five drains installed in 1989 are located along the same fault line, and two were installed downgradient of the old pond area [2].

- The French drain trenches were excavated to the depth of backhoe refusal at the top of the bedrock, which was approximately 15 feet. The bottom of the drains is filled with 4-inch pea gravel to a depth of one foot. The pea gravel is covered with approximately two feet of ½- to 1½-inch gravel, and the ditch is backfilled with clay [10].

- Five of the six drilled wells are located along the same axis as the original drains, and are installed close to, or in between, the three original French drains. The remaining drilled well was installed on the southwest corner of the land farm area [6].

- Recovery wells RW-2, 4, 6, 12, and 13 were closed February 1, 1997 as recommended in the 1995 Annual Report with approval from EPA. Recovery wells RW-3,5,9,10, and 14 began the on/off period [12].

- Extracted water is pumped through force mains to an oil/water separator and then to a storage tank. The water is then pumped through fabric filters to remove suspended solids and treated by carbon adsorption to remove organics. Treated groundwater is discharged to storm drains through two outfalls under an NPDES permit [2].

- The carbon treatment system consists of two parallel lines, each with two 2,000-pound canisters in series, to treat organics [2].

TREATMENT SYSTEM DESCRIPTION (CONT.)

System Description and Operation (Cont.)

- An additional carbon treatment system was added in October 1996 to treat metals-contaminated groundwater from RW-15, located near the CCA plant. Originally, the contaminated groundwater from RW-15 was used as make-up water in the CCA plant. As plant operations declined in 1996, so did the demand for make-up water. Therefore, the new carbon treatment system was added to treat this water prior to discharge. The new system consists of two parallel lines, each with two 180-pound canisters set in series. The carbon system was used for less than one year. Plant operations resumed in 1997, and the water extracted from RW-15 was returned to use in plant operations [9].

- A network of six monitoring wells, along with the remaining recovery wells, is used to monitor changes in groundwater quality and water levels annually [7].

- The remaining 12 monitoring wells went from annual sampling to 5-year sampling as recommended in the 1995 Annual Report with approval from EPA [6].

System Operation

- Under the provisions of the 1983 AO, the interim treatment system operated from 1985 until 1989, when it was expanded. The final remedy began operation in September 1989. This report addresses the final remedy [2].

- Quantity of groundwater pumped from the bedrock and overburden aquifers in gallons is shown below [4,5,6,7].

Year	Volume Pumped (gallons)
1989	4,752,300
1990	12,691,050
1991	10,165,250
1992	14,676,650
1993	11,607,000
1994	19,958,200
1995	11,430,140
1996	12,557,350

- Approximately 40,000 pounds of carbon were used from September 1989 until December 1996. The canisters have been changed nine times since the start of the operation. The average volume of water treated by each canister was approximately 10 million gallons. [5,6,7]

- In June 1995, a Five Year Evaluation of the site was performed.

- The oil/water separator extracts small quantities of oil. From September 1992 to December 1995, two 55-gallon drums of oil were extracted from the groundwater [6].

- In late 1996, the site engineer reported that free oils had been detected in piezometer IWE, located near the two farthest downgradient recovery wells, RW-3 and RW-14. No concentrations of contaminants above detection limits have been detected in the recovery wells since 1990. The piezometer IWE was drilled prior to recovery well installation. Once IWE was in place, the casing may have trapped DNAPL, blocking the recovery wells' subsequent zones of influence. [7,9]

- In February 1997, three major changes were made to optimize system operations. First, five recovery wells in which no contaminants had been found above remedial goals for the past four years were removed from operation. Second, five other recovery wells meeting the same criteria for a period of the last three years began a period of on-off operation (three months on, three months off). Finally, the sampling frequency for 12 monitoring wells was decreased to once every five years. These wells have either a history of contaminant levels below detection limits or are in close proximity to wells that will continue to be sampled annually [9].

TREATMENT SYSTEM DESCRIPTION (CONT.)

System Description and Operation (Cont.)

- An additional recovery well is planned near the waste pond. Monitoring well data have shown that contaminants in the groundwater in this area were not being remediated as quickly as other areas of the site [7].
- Monitoring wells M-17 (near CCA Plant) and MW-19 (near Old Pond) are scheduled to be over drilled in June 1998 and replaced with recovery wells. IWE will be over drilled and plugged.

Operating Parameters Affecting Treatment Cost or Performance

Table 3 presents the major operating parameters affecting cost or performance for this technology.

Table 3: Performance Parameters

Parameter	Value
Average Pump Rate	24 gpm
Performance Standard (effluent) (in mg/L)	NPDES effluent limitations Arsenic 0.050 Chromium 0.050 Naphthalene 2.30 Fluoranthene 3.98
Remedial Goal (aquifer) (in mg/L)	PCP 0.20 Benzo(a)anthracene 0.01 Benzo(a)pyrene 0.01 Benzo(b+k)fluoranthene 0.01 Chrysene 0.01 Arsenic 0.05 Chromium 0.05

Source: [2]

Timeline

Table 4 presents a timeline for this remedial project.

Table 4: Project Timeline

Start Date	End Date	Activity
1984	1989	Interim extraction system built and operated
11/86	---	Record of Decision signed
12/86	7/89	Remedial design and construction performed
1989	ongoing	Final extraction system operational
6/95	---	Five Year evaluation
10/96	---	RW-15 brought into treatment network, and two additional carbon filters to treat metals added to treatment system
2/97	---	System optimization performed

Source: [2]

TREATMENT SYSTEM PERFORMANCE

Cleanup Goals/Standards [1, 5]

- The cleanup goal stated in the ROD was to treat the groundwater contamination to levels that posed no health or environmental risk. This goal is to be achieved throughout the on-site aquifer.
- The cleanup goal for PCP was equal to the EPA reference dose. Goals for benzo(a)pyrene, benzo(a)anthracene, benzo(b+k) fluoranthene, and chrysene were set at the respective detection limits. Goals for arsenic and chromium were set at the maximum contaminant level (MCL) stipulated in 40 CFR 264.94, as listed in Table 3.

Treatment Performance Goals [1]

- The goal of the treatment system is to reduce effluent contaminant concentrations to meet NPDES permit requirements.
- The goal of the recovery system is to contain the plume on site.

Performance Data Assessment [4, 5, 6, 7]

For the purpose of this report, total contaminants includes arsenic, PCP, chromium, and total PAHs.

- Groundwater contamination has been reduced to one localized area of concern. The wells on the western portion have recorded contaminant levels below detection limits. RW-15 and other wells located around the CCA plant and pond area still show contaminant levels above the remedial goals.
- Between April 1989 and May 1996, average concentrations of total contaminants in the groundwater were reduced 32%, from 0.14 mg/L to 0.09 mg/L. Over this same period, average arsenic concentrations increased 20%, from 0.0030 mg/L to 0.0036 mg/L. Average PCP levels decreased 50%, from 0.022 mg/L to 0.011 mg/L. Average chromium concentrations decreased 83%, from 0.030 mg/L to 0.005 mg/L. Total PAHs decreased 34%, from 0.035 mg/L to 0.023 mg/L. Contaminant concentrations in some individual wells remain above remedial goals.
- PCP concentrations detected during the May 1996 monitoring were above the cleanup goal of 0.10 mg/L in five wells (RW-1, RW-7, RW-8, RW-15, and M-17). The maximum concentration of PCP detected in May 1996 was 6.6 mg/L (in RW-15, near the former CCA plant). Elevated levels of PCP also showed in the wells near the former pond area (RW-1, RW-7, RW-8, and M-17). Figure 2 illustrates that the PCP concentrations in the monitoring wells near the pond area have declined, but remain above the cleanup goal of 0.10 mg/L.
- Concentrations of contaminants detected in the May 1996 monitoring were below remedial goals in all but six of the 35 wells monitored. Arsenic concentrations were above the remedial goal of 0.05 mg/L in only one well (RW-15) at 0.69 mg/L. Chromium concentrations were above the remedial goal of 0.05 mg/L in only one well (RW-15) at 0.13 mg/L. Total PAHs concentrations were above the combined remedial goal of 0.40 mg/L in only one well (IWB-170) at 1.18 mg/L. The plume of total contaminants is concentrated in the former CCA plant area, in RW-15 and IWB-170. Figure 3 illustrates that the concentrations of PCP, chromium, and arsenic in RW-15 have declined since January 1991, but remain above the respective remedial goals.

TREATMENT SYSTEM PERFORMANCE (CONT.)

Performance Data Assessment (Cont.)

- RW-15 remains the well with the highest levels of contaminants, specifically arsenic, chromium, and PCP. This well is located 100 feet downgradient of the CCA plant and upgradient of the pond area. The contamination found in this well reflects its proximity to both the CCA plant and the location of the old PCP plant. Overall, contaminant concentrations in this well have decreased during remedial operations (see Figure 3). Reasons for the sharp spikes in concentrations seen in both the first quarter of 1990 and the third quarter of 1991 are not known [9]. By the second quarter in 1996, concentrations of all three of the contaminants remained above remedial goals [7].

- The monitoring data for the wells downgradient of the land farm show that the concentrations of all contaminants remained below detection levels, indicating successful plume containment. Moreover, monitoring results from wells placed downgradient of the pond area but upgradient of the land farm show no evidence that contamination is moving between the two areas.

- Monitoring data have indicated that the area of contamination has decreased in size. The site operators have recommended that wells in the western portion of the site be either removed from service or operated on an on-off basis. The remaining wells around the waste pond still show contaminant levels higher than cleanup goals. It is estimated that the P&T system will operate for a minimum of five more years to reach the specified goals.

- Because contamination was found along rock fractures and not in a continuous plume, plume size reduction cannot be measured.

- NPDES limits have been exceeded six times for hazardous pollutants (arsenic or chromium) from July 1989 through December 1996. Only one out of the six exceedances was from Outfall 001, the treated groundwater. The other exceedances were at a stormwater outfall. Over the same period, effluent samples failed once for Seven-Day Renewal Chronic Toxicity to Certiodaphia and 10 times for reproduction criteria. Exceedances were reported to the Arkansas Department of Pollution Control and Ecology. No process changes were made.

- Figure 4 presents the removal of contaminants through the treatment system from 1990 to 1996. Over this period, a total of 93 million gallons of groundwater were treated, at a daily average treatment rate of 24 gpm.

- During the first seven years of operation, the carbon filter system removed a total of 363 kg of PCP. Other contaminants were removed as well, but sufficient data were not available to be able to estimate their mass. Therefore, removal of total contaminants is likely to be higher.

- PCP removal rates, reported in annual performance reports, declined from 0.39 kg/day in 1990 to 0.03 kg/day in 1995.

Performance Data Completeness

- The 18 monitoring wells and the 15 recovery wells located at the site were monitored on an annual basis and reported in the annual report.

- The data used in Figures 3 and 4 were taken from the summary table in the 1996 Annual Report [7].

- Data for contaminant removal through the carbon filter system were reported in the 1994 Annual Report and Five Year Evaluation, the 1995 Annual Report, and the 1996 Annual Report [4,6,7].

TREATMENT SYSTEM PERFORMANCE (CONT.)

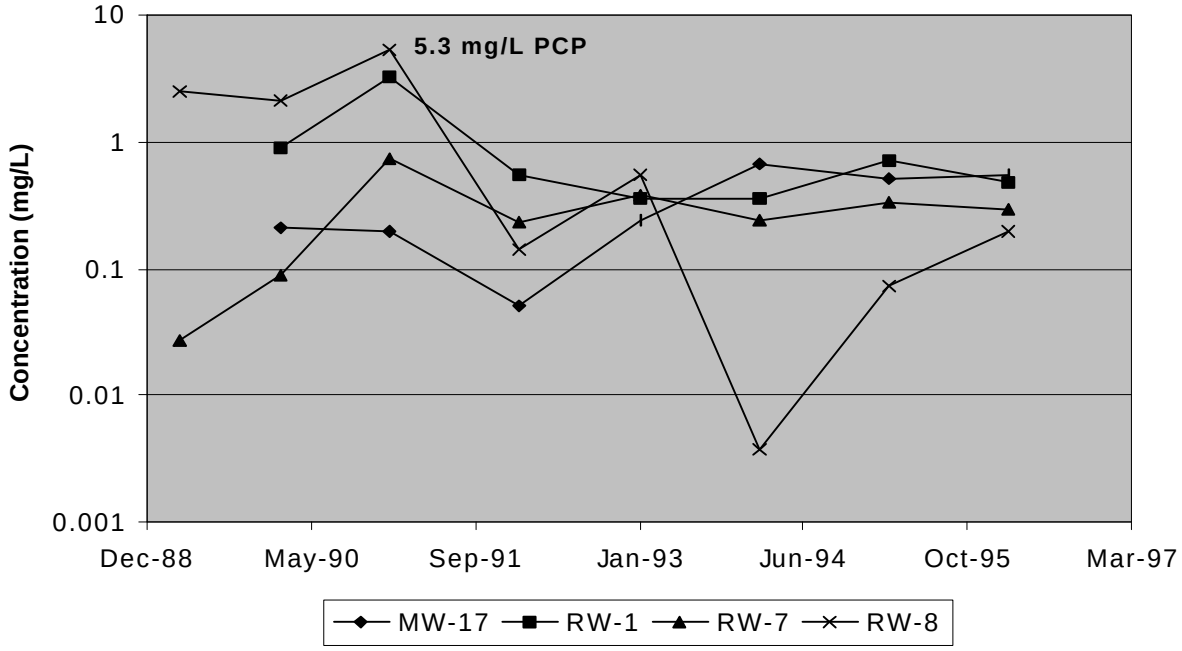

Figure 2. PCP Concentrations in Wells Near Pond Area (April 1989 to May 1996) [4,5,6,7]

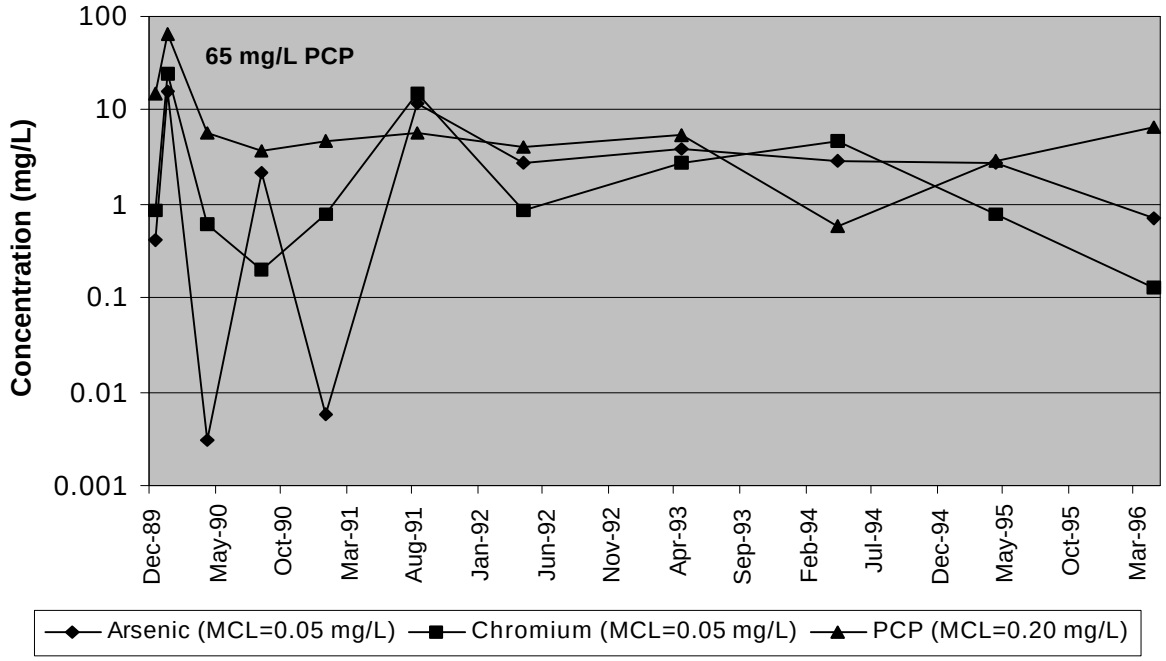

Figure 3. Contaminant Concentrations in RW-15, Near CCA Plant (April 1989 to May 1996) [4,5,6,7]

TREATMENT SYSTEM PERFORMANCE (CONT.)

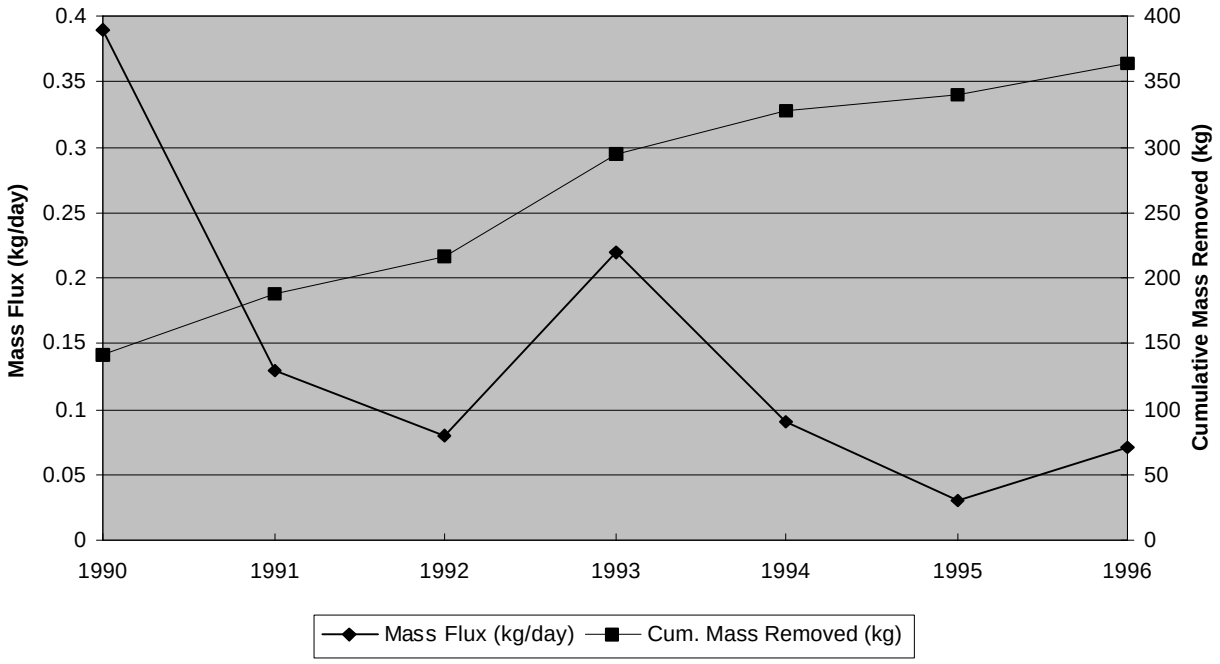

Figure 4. Mass Flux Rate and Cumulative PCP Removal (1990 to 1994) [5]

Performance Data Quality

The QA/QC program used throughout the remedial action met the EPA and the State of Arkansas requirements. All monitoring was performed using EPA-approved methods, and the vendor did not note any exceptions to the QA/QC protocols.

TREATMENT SYSTEM COST

Procurement Process

B&F Engineering provided remedial design services and has provided monitoring and reporting services during the P&T operation period. Rollins provided construction services and Mid-South Wood Products (one of the two PRP's) has operated the P&T system.

Cost Analysis

All costs for design and construction and operation of the treatment system at this site were borne by the PRPs.

Capital Costs [6]

Remedial Construction and Design	
Mobilization, Bond & Insurance	$25,560
Health and Safety	$7,875
French Drain Construction	$95,100
Recovery Well Casings	$45,470
Recovery Well Pumps	$28,900
Rock Excavation	$11,393
Cable	$26,818
Treatment Plant	$141,990
RW-15 Well and Treatment Unit	$24,700
Miscellaneous	$57,470
Total Site Cost	**$465,276***

*Does not include stabilization, consolidation, and capping costs for remediation of contaminated soils.

Operating Costs [6]

Carbon Regeneration	$100,100
Sludge, Oil, Filter, etc. Disposal	$8,400
Miscellaneous Pipe, Filters, etc.	$10,500
Operating Labor Cost	$54,600
Contract Labor Cost	$8,400
Electrical Power Cost	$33,600
Analysis, Reporting, and Monitoring	$395,800
Annual Report	$24,500
Five Year Evaluation	$14,000
Carbon Canister Replacement	$45,000
Pump Replacement	$17,200
Meter Replacement	$2,600
Electrical Controls Replacement	$6,600
Filter Replacement	$4,000
Operator Training Cost	$4,000
Contingency Fund	$18,000
Estimated Total Operating Expenses Through 1996	**$747,300**

Note: Operating costs are based on annual cost estimates provided by B&F Engineering.

Annual Costs [8]

1990	$136,350
1991	$103,350
1992	$88,350
1993	$90,350
1994	$88,750
1995	$152,000
1996	$88,150

Cost Data Quality

Estimated capital and operating and maintenance cost data are available from the system operator for this application.

OBSERVATIONS AND LESSONS LEARNED

- The site engineer identified one change order for the original groundwater treatment system construction contract, totaling $9,966.

- Estimated costs for the P&T treatment application at Mid-South were approximately $1,212,600, consisting of $465,300 in capital costs and $747,300 in cumulative operating and maintenance costs through 1996 [8]. This corresponds to unit costs of $13 per 1,000 gallons treated and $3,330 per kg PCP removed ($4,510 per pound PCP removed).

- The use of fabric filters to remove suspended solids has increased the operating life of the carbon filters. The high rate of changeout for the fabric filters has not added a significant level of effort to routine operations [8].

- The increase in mass flux seen in 1993 may be attributed to an increase in precipitation during the year. The increased precipitation could have accelerated groundwater flows, which would then cause a contaminant level increase in the recovery wells.

- DNAPLs have been visually observed from a drilled well at 172 feet of depth. The presence of DNAPL at the site also is suggested by fluoromethane, benzo(a)anthracene, and chrysene being detected at concentrations 60%, 63%, and 30% of their aqueous solubility, respectively. Similarly, PCP was detected at concentrations greater than its aqueous solubility. Further, a monitoring well near the waste pond has shown persistent elevated contaminant concentrations when compared to the other wells at the site [2,4].

- Initially, French drains were chosen to recover groundwater because engineers believed that the fractured nature of the bedrock would result in low yields from a system composed only of drilled extraction wells. Actual experience at this site has shown that the extraction rates from the French drains are much lower than those from the drilled extraction wells, and that pumping from the drilled wells has significantly changed groundwater flow patterns at the site [6].

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Analysis Preparation

This case study was prepared for the U.S. Environmental Protection Agency's Office of Solid Waste and Emergency Response, Technology Innovation Office. Assistance was provided by Eastern Research Group, Inc. and Tetra Tech EM Inc. under EPA Contract No. 68-W4-0004.